

Assessment of Aquatic Macroinvertebrates on USFS / BLM Lands of the Crooked and Sage Creek Watersheds

**Prepared for Darin Watschke, USFS Custer National Forest, Billings,
Agreement 05-CS-11015600-036**

by

**David M. Stagliano
Aquatic Ecologist
August 2009**



Crooked Creek upstream of Fish Exclusion Barrier



Acknowledgements

We would like to thank Darrin Watschke, USFS Custer Forest in the Billings Office, and Ann Carlson of the USFS Region 1 office in Missoula for implementing the agreement 05-CS-11015600-036 from which most of the macroinvertebrate work is taking place. Meghan Burns expertly provided the GIS map and Amandi Standley helped process the macroinvertebrate samples. Paul Hendricks, MTNHP identified the terrestrial snails collected during this site visits.

All photos in the report were taken by MTNHP personnel, unless otherwise noted

Crooked and Sage Creek Watershed Aquatic Assessment

Objectives.

Project goals of the 2008 MTNHP Aquatic Surveys of the Crooked and Sage Creek Watersheds were: 1) to sample and assess aquatic macroinvertebrate community integrity and diversity in relation to the Crooked Creek fish exclusion barrier completed in 2007; compare upstream and downstream macroinvertebrate communities.

2) to evaluate additional aquatic sites in the area of interest potentially containing unique, species of concern (SOC) or important indicator macroinvertebrate taxa in relation to future restoration projects (i.e., Sage Creek).

Habitat Evaluations.

On-site habitat assessments were conducted using the rapid assessment protocol (RBP Level 1, scores 0-200) developed for the EPA by Barbour et al. (1999) with modifications and additions by the National Aquatic Assessment of the Bureau of Land Management (BLM)(scores 0-24) (<http://www1.usu.edu/buglab/forms/Bug%20Protocol%20form.pdf>). Using the BLM assessment protocols, the reach was divided into 10 equally spaced transects. Parameters recorded at each were: wetted width, bankfull width, 3 channel depth measurements, large woody debris, riparian shading and benthic substrate (in % composition per transect) based on Wollman size-classes were measured at each transect perpendicular to the stream channel. Basic water chemistry parameters (temperature, pH, conductivity) were recorded prior to sampling using a Horiba H-10 water monitor. The goal of these evaluations is to characterize local reach geomorphology, riparian and in-stream habitat, and other characteristics that influence aquatic community integrity. The LUI (Livestock Use Index) was also incorporated into the riparian habitat assessment, this involved a 75m zig-zag walk from the bottom of the reach on the left and right banks of the stream channel visually counting the number of cow pies, and noting if these are new or old (see BLM Assessment Sheet: <http://www1.usu.edu/buglab/forms/Bug%20Protocol.pdf>). Sites ranking higher using these protocols are determined to have higher quality local-scale habitat. Habitat assessments were performed during the same visit as the biological sampling.

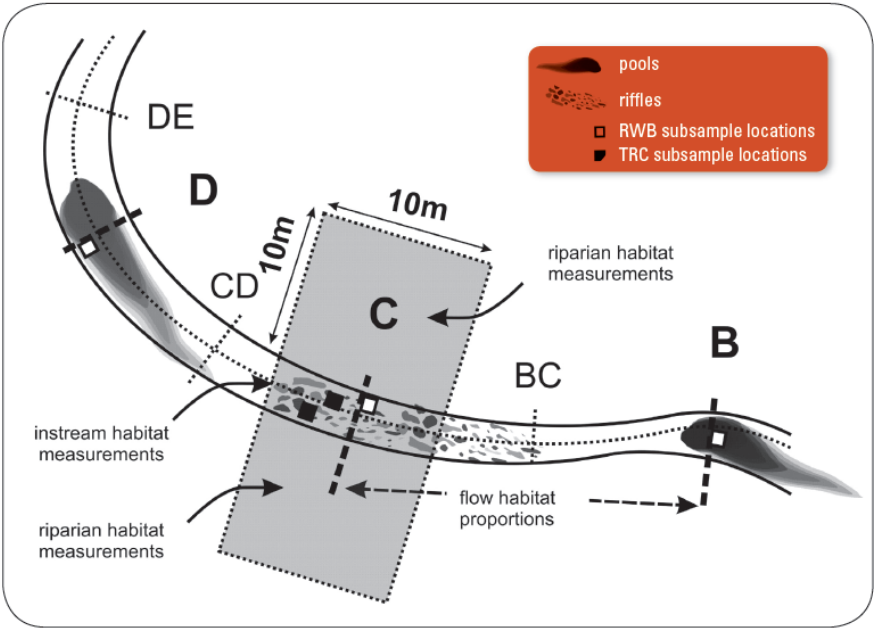
Macroinvertebrate Communities:

Macroinvertebrates were collected from riffle geomorphic habitat units from evenly spaced transects along and across the reach with a 500-micron D-frame net (8 discrete samples). This method follows the EMAP Targeted Riffle protocol outlined in Lazorchak (1998) and modified for the BLM National Monitoring Lab (<http://www1.usu.edu/buglab/forms/Bug%20Protocol.pdf>)

All 8 samples (8 x 0.075m²) taken within the transects were composited into a 5 gallon bucket, and the organisms were washed onto a 500-micron sieve, transferred to a 1 liter Nalgene bottle, labeled and preserved in 95% ethanol and brought to the MTNHP lab in Helena for processing. Small, low volume (trickle) spring macroinvertebrate samples (Sage Creek Campground Spring, Commissary Creek Spring) were collected opportunistically with dipnets and aquarium nets

covering all habitats within the reach. Moss samples (1ft²) taken above the fish barrier were measured with a ruler and scraped off the cobbles by hand so as not to disturb the underlying cobbles.

Figure 1. EMAP Targeted Riffle Composite protocol used in macroinvertebrate collection.



Samples were processed (sorting, identification, and data analysis) by the author (D. Stagliano) at the Helena NHP lab following BLM National Aquatic Monitoring Methods (sensu stricto EMAP protocols Lazorchak et. al.1998). Macroinvertebrates (500 individuals per sample when available) were identified to the lowest taxonomic level, imported into EDAS (Jessup 2006), and biological integrity metrics were calculated from the data using the newest multimetric macroinvertebrate (MMI) protocols (Jessup et al. 2005, Feldman 2006). Metric results were then scored using the Montana DEQ bioassessment criteria and each sample categorized as non-impaired or impaired according to threshold values (Table 1). The impairment threshold set by MT DEQ is 48 for the Low Mountain/Valley Index and 63 for the Mountain Index thus any scores above this threshold are considered unimpaired.

Table 1. Impairment determinations from the MMI and O/E (RIVPACS) models (taken from Jessup 2005, Feldman 2006).

Ecoregion	RIVPACS	MMI	Impairment Determination
Mountain	≥ 0.8 or ≤ 1.2	≥ 63	Not impaired
	< 0.8 or > 1.2	< 63	Impaired
Low Valley	≥ 0.8 or ≤ 1.2	≥ 48	Not impaired
	< 0.8 or > 1.2	< 48	Impaired
Eastern Plains	≥ 0.8 or ≤ 1.2	≥ 37	Not impaired
	< 0.8 or > 1.2	< 37	Impaired

The macroinvertebrate MMI score is based upon a series of metrics that measure attributes of benthic macroinvertebrate communities correlating with changes to a stream system (in the form of anthropogenic caused changes). There are no existing DEQ impairment criteria for Spring Macroinvertebrate Communities; therefore, we consider the comparison of observed taxa vs. expected “reference condition taxa” from similar springs in the ecoregion (see Stagliano 2008).

Study Sites

All sites chosen for this USFS Crooked/Sage Creek stream evaluation & watershed assessment lie within the USFS Custer National Forest (Pryor Mountains) or the BLM Billings Field Office Management Area in Carbon Co., MT (Figure 2). Habitat assessments, water quality measurements and macroinvertebrate samples were performed in 2008 at 13 lotic sites, 7 of these were pre-determined (per conversation with D. Watschke), and an additional 6 spring-influenced sites within the USFS lands were discovered while accessing other areas of the assessment region (Table 2), 3 sites included in this assessment were sampled in 2007. Three of the apriori chosen stream sites (Cave, Lost Water, and lower Commissary Creek) as well as 9 other randomly visited sites were dry (Table 2). Biological community integrity was calculated at all sites using the macroinvertebrate multi-metrics (MT DEQ MMI's). Site summary descriptions based on the overall community integrity and site observations are included.

Figure 2. Sites visited in the USFS Pryors and BLM lands of the Crooked & Sage Creek Watersheds. Ecological Biointegrity Values are based on habitat evaluations & macroinvertebrate communities (see Methods).

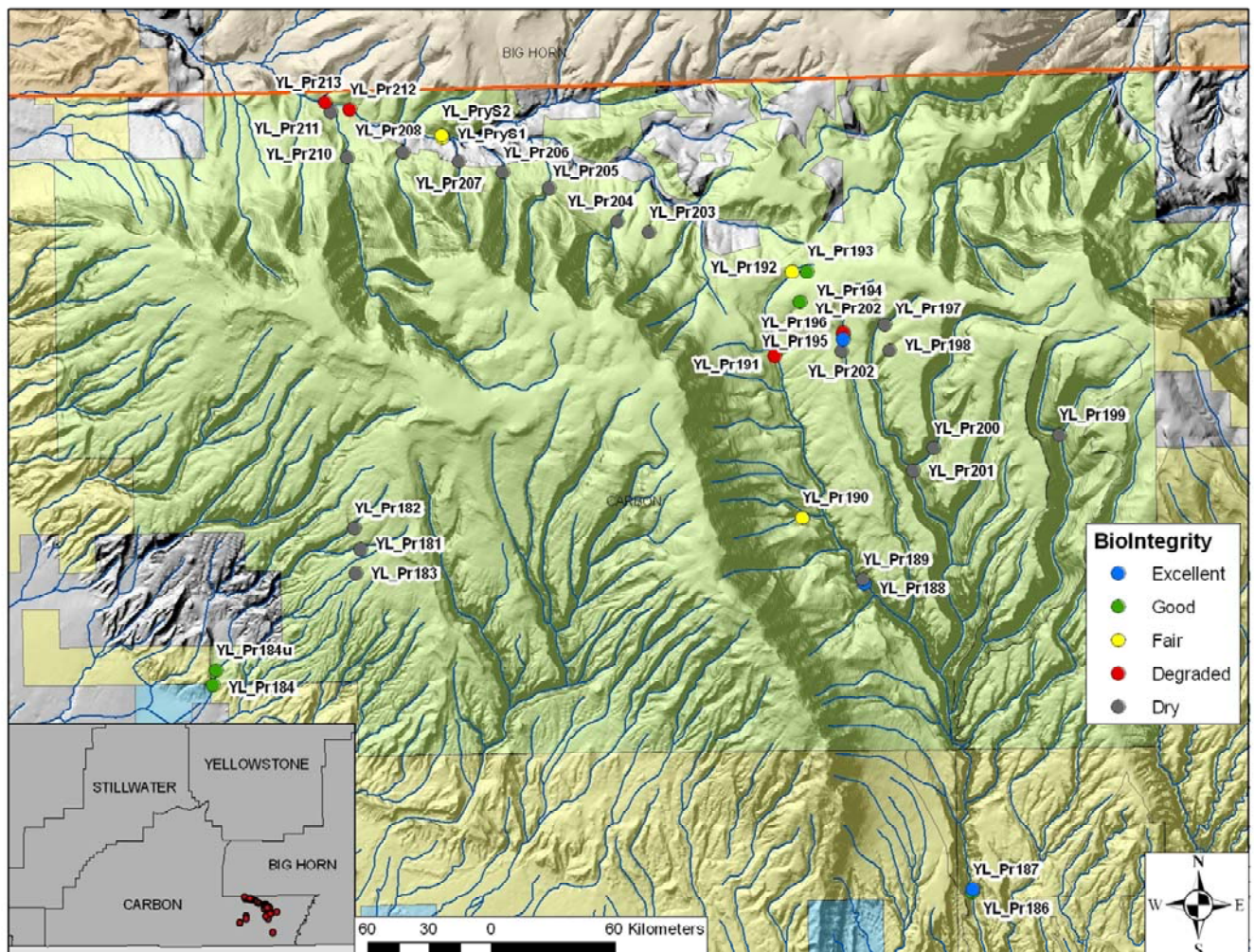


Table 2. USFS Custer Forest Pryor 2008 project sites visited Sept. 3rd-5th. Sites with an asterisk (*) were sampled by NHP in 2007 during another project visit.

Site Code	Sites Visited	HUC	Latitude	Longitude	Elev (ft)	Water Flow	Macro Sample
YL_Pr181	Piney Creek trib	10080014	45.1290	-108.5551	6601	dry	X
YL_Pr182	Piney Creek trib	10080014	45.1332	-108.5567	6743	dry	
YL_Pr183	Piney Creek trib	10080014	45.1245	-108.5565	6506	dry	
YL_Pr184	Piney Creek (BLM)	10080014	45.1031	-108.5958	5022	flowing	
YL_Pr184u	Piney Creek (USFS)*	10080014	45.1060	-108.5950	5031	flowing	
YL_Pr185	Rattlesnake (CRVI) Demijohn Flat	10080010	45.0805	-108.4002	5659	upland	X
YL_Pr186	Crooked Creek blwb	10080010	45.0610	-108.3893	5620	flowing	
YL_Pr187	Crooked Creek abvb	10080010	45.0617	-108.3890	5645	flowing	
YL_Pr188	Crooked Creek upper	10080010	45.1213	-108.4176	5726	flowing	
YL_Pr189	Crooked Creek trib	10080010	45.1220	-108.4180	5792	dry	
YL_Pr190	Wyoming Creek	10080010	45.1341	-108.4342	6177	flowing	X
YL_Pr191	Crooked Creek trib	10080010	45.1655	-108.4412	6631	flowing	X
YL_Pr192	Crooked Creek source	10080010	45.1818	-108.4361	7101	flowing	X
YL_Pr193	Crooked Creek Spring	10080010	45.1818	-108.4320	7240	flowing	X
YL_Pr194	Crooked Creek trib	10080010	45.1758	-108.4341	7172	flowing	X
YL_Pr195	Commissary Creek trib	10080010	45.1695	-108.4234	7329	dry	X
YL_Pr196	Commissary Creek	10080010	45.1698	-108.4225	7279	trickle flow	
YL_Pr197	Cave Creek trib	10080010	45.1712	-108.4111	7332	dry	
YL_Pr198	Cave Creek trib	10080010	45.1664	-108.4098	7403	dry	
YL_Pr199	Lost Water Creek	10080010	45.1494	-108.3637	7196	dry	
YL_Pr200	Cave Creek	10080010	45.1472	-108.3980	6700	dry	X
YL_Pr201	Cave Creek trib	10080010	45.1663	-108.4228	7194	dry	
YL_Pr202	Rock Spring trib	10080010	45.1686	-108.4225	7316	trickle flow	
YL_Pr203	Sage Creek trib	10080014	45.1897	-108.4752	6702	dry	
YL_Pr204	Sage Creek trib	10080014	45.1920	-108.4836	6677	dry	
YL_Pr205	Sage Creek trib	10080014	45.1985	-108.5023	6602	dry	X
YL_Pr206	Sage Creek trib	10080014	45.2017	-108.5150	6654	dry	
YL_Pr207	Sage Creek trib	10080014	45.2039	-108.5269	6624	dry	
YL_Pr208	Sage Creek trib	10080014	45.2058	-108.5422	6612	dry	
YL_Pr210	Sage Creek trib	10080014	45.2049	-108.5574	6588	dry	
YL_Pr211	Sage Creek trib	10080014	45.2137	-108.5619	6576	dry	X
YL_Pr212	Sage Creek	10080014	45.2141	-108.5565	5524	flowing	
YL_Pr213	Sage Creek	10080014	45.2156	-108.5632	5520	flowing	
YL_PryS1	Sage Creek Spring *	10080014	45.2087	-108.5314	5724	trickle flow	
YL_PryS2	Sage Creek Spring *	10080014	45.2091	-108.5316	5753	trickle flow	
YL_Pr214	Sagebrush Lizard (SCGR) incidental	10080014	45.2159	-108.5618	5571	upland	

Results Summary

The Crooked & Sage Creek watersheds of the Bighorn River and Shoshone Basins are typical of Bighorn/Pryor Mountain Upland Douglas Fir/ Ponderosa Pine forest transitioning to a sage-dominated Wyoming Basin landscape. We identified macroinvertebrate communities with moderate-excellent ecological integrity within 3 Aquatic Ecological System Types (AES) during this study: Small Transitional Foothills Streams (C001y), Small Headwater Forested Streams (D001y), and Northwestern Great Plains/Wyoming Basin Perennial Springs (S005). But significant anthropogenic factors exist in this region (ex. Non-native fish introductions, water diversions, improper grazing practices) to render some streams of these aquatic ecological system types in an impaired biological health condition (Sage, Crooked Creek headwaters and Commissary Creek).

Habitat Evaluations. Overall, 6 of the 16 flowing lotic sites had good habitat quality ranked by at least one of the habitat assessment methods (Table 3). Five of the 16 sites were ranked slightly impaired and five moderately to severely impaired. Dry sites visited (19) were not assessed, but generally had fewer riparian and in-stream channel problems because of minimal cattle use. Highest site habitat scores using BLM habitat assessment methods were measured at the 3 canyon Crooked Creek (CC) sites (inaccessible to cattle), Piney Creek, and a tributary to Crooked Creek. Highest deductions to the riparian assessment scores were in stream sediments, % bare ground and bank trampling by cattle intrusions into the riparian zone. These intrusions were specifically measured using the Livestock Use Index (LUI), which was very high for multiple streams including Commissary Creek, headwaters of Crooked Creek, and Wyoming Creek. High sediment loading was documented at Wyoming Creek and both Sage Creek sites despite no overly obvious riparian disruptions in the immediate riparian area of the latter sites.

Macroinvertebrate Communities: Overall, 112 macroinvertebrate taxa were reported from the USFS Custer 2008 assessment sites (Appendix A). Average macroinvertebrate taxa richness per site was 24.67, and the highest taxa richness reported was 48 taxa at the CC site above barrier. Unique or infrequently collected taxa include *Helichus striatus*, a Dryopid riffle beetle collected only below the fish barrier and *Meringodixa chalonensis*, a cold-water obligate dipteran taxa found only in the CC tributary sample. The upper canyon Crooked Creek site (YL_Pr188) had the only reported collection of the cold-water caddisfly, *Rhyacophila hyalinata* gr. in good numbers; while Wyoming Creek reported the only occurrence of *Rhyacophila oreata*, a spring influenced associate caddisfly. Two unique riffle beetles, *Lara avara* and *Narpus concolor* were only reported from the Sage Creek sites; these are typically associated with large woody debris (LWD). Using the Montana DEQ multimetric index (MMI), 8 (10 samples) of the 16 sites were ranked non-impaired (good to excellent biological integrity), 4 were slightly impaired and 4 were moderately-severely impaired (Figure 2, Table 3).

All sample sites within the Crooked Creek canyon showed good to excellent benthic integrity. The progression of decreasing biointegrity (as measured by the DEQ MMI) as one proceeds up and out of the Crooked Creek Canyon is significant, and seems causally linked to increasing riparian degradation as cattle have access to the tributaries and mainstem of Crooked Creek (Figure 3).

Within Crooked Creek sample comparisons: there was no significant difference in macroinvertebrate community quality ranked by MT DEQ MMI above and below the barrier

(Figure 2), but there was a slight difference in the furthest upstream Crooked Creek canyon site (MMI=85), which had more coldwater community taxa (Table 3).

Figure 3. Macroinvertebrate MMI scores from Crooked Creek (CC) below the fish barrier (FB) to the Source Spring. Dotted line is the impairment threshold score(63).

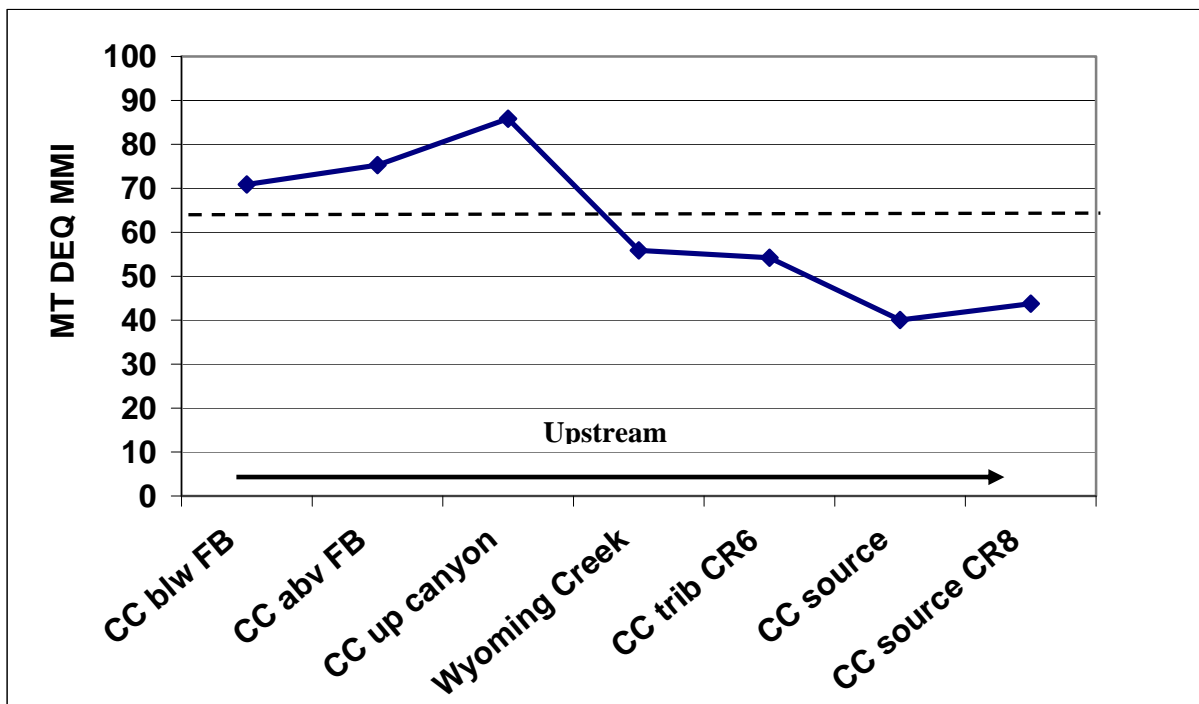
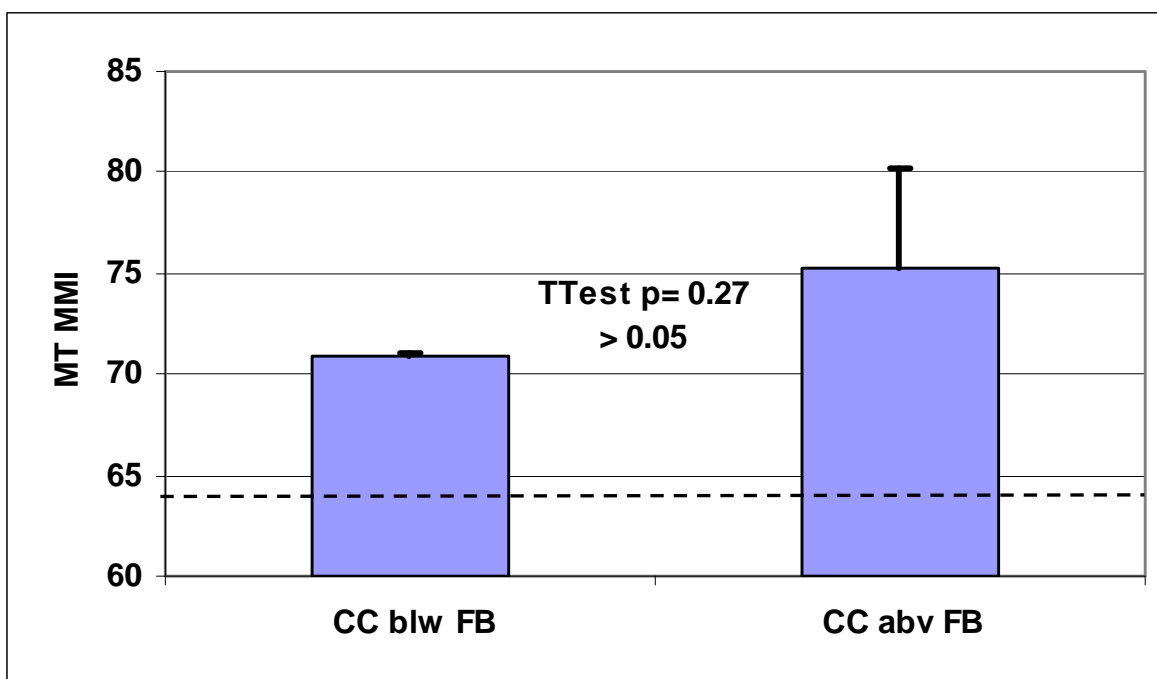
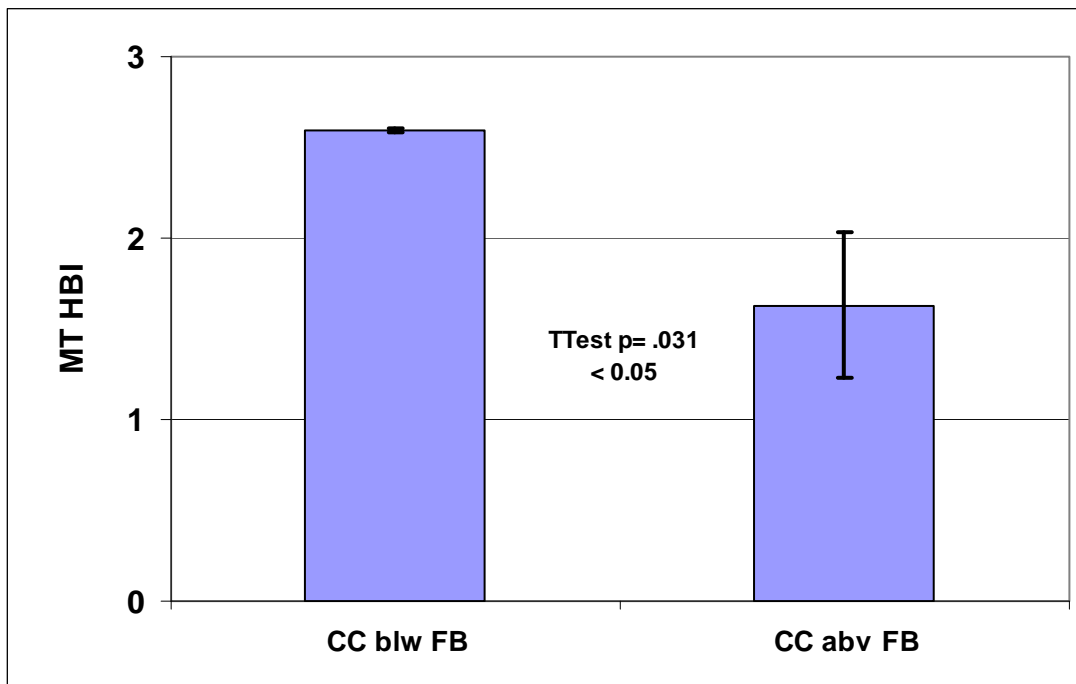


Figure 4. MMI scores from Crooked Creek (CC) above and below the fish barrier (FB). Error bars=SE (n=2). Dotted line is the impairment threshold score (63).



Despite no difference in the MMI scores above and below barrier, the species richness above the barrier is noticeably higher (42.5 vs. 29.5), but not significant (TTEST = 0.12, unequal variances) (Table 3) and the coldwater taxa above far outnumber those below the barrier (15 vs. 8 spp.) The Hilsenhoff Biotic Index Scores (HBI: lower scores are better) indicate that the macroinvertebrate community downstream of the barrier is significantly more tolerant to organic enrichments (Figure 5).

Figure 5. HBI scores for Crooked Creek above and below the fish barrier (FB). Error bars=SE (n=2).



The moss grab samples resulted in a slightly different macroinvertebrate community than the whole composite. Moss grabs (1ft²) did not contain large stoneflies which prefer large cobble substrate, but had abundant mayfly, chironomid and caddisfly taxa with total numbers averaging 250 individuals per ft² of moss or about 2,675 individuals per m². Submerged moss growing on cobbles represented a significant portion of the benthic channel in the reaches above and below the barrier, averaging 2.0 m per 4.8m wetted width or about 42% of benthic coverage (see red box in site photos).

Table 3. Macroinvertebrate taxa richness, DEQ MMI= Multimetric Macroinvertebrate Index and Observed/Expected (O/E) scores for the spring sites. BLM Site Habitat Evaluation (>20=PFC), and WQ parameters LUI=Livestock Use Index, Cond =Conductivity. Bold-underlined scores are good-excellent index scores, shaded grey represent fair-good integrity conditions.

Site Code	Sites Sampled	BLM Site Eval	Taxa Richness	MMI	O/E	LUI	pH	Cond.	Temp.
YL_Pr184	Piney Creek (BLM land)	19 (79%)	29	62.97	na	12	7.4	291	7.9
YL_Pr184u	Piney Creek Spring (USFS)	21 (88%)	9	na	0.55	0	7.3	277	7.2
YL_Pr186	Crooked Creek blw barrier	22 (92%)	29	71.00	na	0	7.3	326	10.1
YL_Pr186_#2	Crooked Creek blw barrier	22 (92%)	30	70.79	na	0	7.3	326	10.1
YL_Pr187	Crooked Creek abv barrier	24 (100%)	37	70.44	na	0	7.3	351	9.0
YL_Pr187_#2	Crooked Creek abv barrier	24 (100%)	48	80.15	na	0	7.3	351	9.0
YL_Pr188	Crooked Creek upper	22 (92%)	30	85.82	na	0	7.6	365	5.8
YL_Pr190	Wyoming Creek	18 (75%)	37	55.87	na	15	7.6	499	5.2
YL_Pr191	Crooked Creek trib	17 (70%)	30	54.20	na	28	7.6	403	5.4
YL_Pr192	Crooked Creek source	15 (62%)	16	40.04	na	18	7.6	410	7.3
YL_Pr193	Crooked Creek Spring	19 (79%)	17	43.74	0.75	11	7.6	407	6.9
YL_Pr194	Crooked Creek trib	17 (70%)	15	41.18	0.6	16	7.6	411	7.8
YL_Pr196	Commissary Creek	17 (70%)	7	53.93	na	11	7.6	493	6.2
YL_Pr202	Rock Spring trib	18 (75%)	12	50.34	0.75	4	7.5	485	9.6
YL_Pr212	Sage Creek (campground)	19 (79%)	39	46.19	na	0	7.6	512	9.8
YL_Pr213	Sage Creek (below)	19 (79%)	40	38.95	na	0	7.6	508	11.5
YL_PryS1	Sage Creek Spring (low)	18 (75%)	12	27.76	0.48	0	7.6	323	9.7
YL_PryS2	Sage Creek Spring (up)	18 (75%)	8	32.66	0.54	0	7.6	344	19.0

Community results from the habitat and macroinvertebrate surveys combined to rank the following sites from highest biological integrity to lowest.

Overall Aquatic Ecological System Site Condition (in order of highest integrity to worst by AES):

Small Transitional Foothills Stream (AES C001y)-1) Crooked Creek (above barrier), 2) Crooked Creek (below barrier), 3) Piney Creek, 4) Sage Creek

Small Forested Headwater Stream (AES D001y)-1) Upper Crooked Creek, 2) Wyoming Creek, 3) Commissary Creek

Wyoming Basin Perennial Spring (AES code S005) - 1) Crooked Creek source spring, 2) Rock Spring (my name), 3) Commissary Creek Spring

Other Invertebrates

Most of the dry stream washes from Piney Creek and Crooked Creek drainages, including Lost Water, Cave Creek and Commissary Creek contained abundant terrestrial snail populations, the most common species appear to be the Subalpine Mountainsnail, *Oreohelix subrudis* (see photo). But there is also a smaller form as well (from sites #181, 182: dry washes upstream in Piney Creek) that is perhaps *Oreohelix strigosa berryi*, which is a MT Species of Concern (S1S2) (P. Hendricks, MTNHP, pers. comm.).



Site Descriptions

Management/Threats to these ecological systems include:

Grazing and livestock use around the riparian areas occurs and can have strong local effects resulting in sedimentation and stream widening at cattle crossings. Introductions of game or forage fish in downstream reaches or anywhere in the watershed can make their way upstream to these foothills rivers and become permanent residents.

Crooked Creek (Mainstem Site #1 below Fish Barrier)

Location: Accessed from 4-wheel drive trail from Demijohn Flat dropped into barrier site and walked downstream ~200m to the first riffle/pool set designated the top of the lower reach then went 150 m down to start sampling in the upstream direction.



Nearest Town: Lovell, WY

Ecoregion: Wyoming Basin (Typical)

Aquatic Ecological System Type: C001y.

Key Environmental Factors: Upstream Riparian Grazing in the tributaries- substantial impacts, introduced fish populations. Riparian Modifications- moderate, recovering.

Rare or Unique Species: No rare species, but a diverse foothills macroinvertebrate assemblage including *Helichus striatus*, a Dryopid riffle beetle found only at this site.

Rare Features: An aesthetic canyon with oasis-type qualities and a native Yellowstone cutthroat trout population.

Introduced/Exotic Aquatic Species:

Introduced fish---Rainbow Trout reported in this reach below barrier (FWP MFISH, USFS pers. com.)

Overall Ecological Site Condition: Good

Reach Summary: The 150m reach consisted of 3 riffle/run/pool complexes with riffle/run geomorphology dominating the reach (125m) averaging 0.20m in depth. The mid and lower complex contain 8-10m long pools

averaging 0.4m in depth, and contained good fish holding habitat. This stream reach lacked a diversity of microhabitats, cobbles dominated the substrate (70% of transects) and lacked undercut banks or large woody debris. The substrate of the pool was gravel/pebble dominated with some silt and cobbles.

Vegetation coverage along the riparian stream channel was dominated by trees & shrubs and largely intact. Livestock use index (LUI) was absent with 0 cow pies counted on a 75m walk of both left and right banks.

Reach Riparian Ranking: BLM= 92% (22 of 24)

Macroinvertebrate Community Quality: MTMMI= 70.8

Crooked Creek (Mainstem Site #2 above Fish Barrier, cover photo)

Location: Accessed from 4-wheel drive trail from Demijohn Flat dropped into barrier site and walked upstream ~200m to the first riffle/pool set designated the bottom of the upper barrier reach then went 150 m upstream from that point to sample in the upstream direction.



Nearest Town: Lovell, WY

Ecoregion: Wyoming Basin (Typical)

Aquatic Ecological System Type: C001y.

Key Environmental Factors: Upstream Riparian Grazing in the tributaries: mod-substantial impacts, introduced fish populations: low-mitigated by the barrier. Riparian Modifications & grazing in the canyon are minimal. Fire-killed trees on the steep canyon slopes ~2km upstream of reach.

Rare or Unique Species: No rare species, but a diverse foothills macroinvertebrate assemblage with 15 coldwater obligate taxa.

Rare Features: An aesthetic canyon with oasis-type qualities and a native Yellowstone cutthroat trout population.

Introduced/Exotic Aquatic Species:

Introduced fish---Rainbow Trout reported in this reach below barrier (FWP MFISH, USFS pers. com.)

Overall Ecological Site Condition: Good to Excellent

Reach Summary: The 150m reach consisted of 3 riffle/run/pool complexes with riffle/run

geomorphology dominating the reach (125m) averaging 0.20m in depth. The mid and lower complex contains 8-10m pools averaging 0.4m in depth, and contained the most fish holding habitat. This stream reach lacked a large diversity of fish holding macrohabitats, cobbles dominated the substrate (70% of transects) and lacked undercut banks and few large woody debris. The substrate of the pool was gravel/pebble dominated with some silt and cobbles. Vegetation coverage along the riparian stream channel was dominated by trees & shrubs and largely intact. Livestock use index (LUI) was none with 0 cow pies counted on a 75m walk of both left and right banks.

Reach Riparian Ranking: BLM= 100% (24 of 24)

Macroinvertebrate Community Quality: MTMMI = 75.3

Crooked Creek (Mainstem Site YL S188 above Fish Barrier upper canyon)

Ecoregion: Pryor/Bighorn Mountain Foothills

Aquatic Ecological System Type: D001y-Forested Headwater River

Key Environmental Factors: Riparian Grazing—slight to moderate impacts upstream, but none in the immediate reach. Fire-killed trees on the steep canyon slopes within the reach may contribute to LWD additions to the stream for increased habitat complexity.



Rare or Unique Species: No rare SOC species, but abundant cold-water caddisfly, *Rhyacophila hyalinata* gr present in the samples

Rare Features: No rare features documented

Introduced/Exotic Aquatic Species: None

Overall Ecological Site Condition: Good to Excellent

Reach Summary:

This stream reach has moderate quality instream aquatic habitat with some boulder drop pools and LWD overhangs. Livestock use index (LUI) was zero, with no livestock able to access this site in the canyon.

Riparian Ranking: BLM= 92% (22 of 24)

Proper Functioning Condition (PFC)

Reach Riparian Geomorphology: The geomorphology of this stream reach is a Rosgen B-3 with a medium gradient (2 %), moderate sinuosity, a riffle dominated configuration with substrate dominated by cobble/boulders and pebble runs. Pools are small-largely absent averaged >30 cm in depth, average wetted width of the reach was 2.8m.

Macroinvertebrate Community: This excellent quality community is dominated by the Traditional Trout Stream Assemblage (#90, Stagliano 2005) and members of the Small Foothills Transitional Assemblage (#105, Stagliano 2005), overall a diverse macroinvertebrate assemblage with 11 coldwater obligate taxa.

Macroinvertebrate Community Quality: DEQ MMI= 85.8

Wyoming Creek (YL Pr190)

Ecoregion: Pryor/Bighorn Mountain Foothills

Aquatic Ecological System Type: D001y-Forested Headwater Stream

Key Environmental Factors: Riparian Grazing & Cattle Use—moderate impacts, near stream pocking. Some sediment loading from riparian trampling or upstream beaver activity.



Rare or Unique Species: No SOC species, but a unique species to this assessment, the caddisfly, *Rhyacophila oreta*.

Rare Features: No rare features documented

Introduced/Exotic Aquatic Species: None collected.

Overall Ecological Site Condition: Fair trending to Good with proper grazing management.

Reach Riparian Ranking: BLM= 18 (75%)
Reach

Functional At Risk Riparian Condition (FAR)

Geomorphology: Rosgen B4. Surrounding bank materials are finer than the channel bed materials, gravel to pebble dominated substrate, with embedded cobbles and some LWD derived from a beaver upstream? (beaver chewed sticks). Cobbles have a dense moss growing on them increasing the microhabitat diversity.

Macroinvertebrate Community: A fairly diverse community of 37 taxa, including 8 cold-water obligate taxa, despite some obvious sediment loading issues and embedded cobbles. Also contains taxa indicative of a Wyoming Basin Spring indicating obvious spring discharge influence in the drainage.

Macroinvertebrate Community Quality: MMI= 55.87

Crooked Creek Trib/Mainstem (YL Pr191)

Ecoregion: Bighorn-Pryor Mountains/Wyoming Basin (Typical)

Aquatic Ecological System Type: D001y-Forested Headwater Stream

Key Environmental Factors: Riparian Grazing & Cattle Use—moderate impacts, near stream pocking. Some sediment loading from riparian trampling and instream cattle use.



Rare or Unique Species: No SOC species, but a unique species to this assessment, *Meringodixa chalonensis*, a cold-water obligate dipteran taxa.

Introduced/Exotic Species: None documented

Overall Ecological Site Condition: Degraded/Fair trending to Good with improved cattle management.

Riparian Ranking: BLM= 17 (70%)

Functional At Risk Riparian Condition (FAR)

Fish Community: No fish species collected or expected.

Macroinvertebrate Community Quality: A fairly diverse community of 30 taxa, including 8 cold-water obligate taxa, despite some obvious impairments from sediment loading issues, riparian degradation and embedded cobbles. Also contains 6 taxa indicative of a Wyoming Basin Spring indicating obvious spring discharge influences in the drainage.

Macroinvertebrate Community Quality: DEQ MMI= 43.7

Crooked Creek Spring Source (YL Pr193)

Ecoregion: Bighorn-Pryor Mountains/Wyoming Basin (Typical)

Aquatic Ecological System Type: S005-Wyoming Basin Perennial Spring

Key Environmental Factors: Grazing—slight-moderate impacts, some fenced areas-but some riparian intrusions and degradation of riparian shrub, grasses and willows.



Rare or Unique Species: An oasis of a fairly healthy spring community of aquatic insects within a high forest-sagebrush transition landscape.

Introduced/Exotic Species: None documented

Overall Ecological Site Condition: Fair trending to Good with improved cattle management.

Reach Riparian Ranking: BLM= 79% (19 of 24)

Functional At Risk Riparian Condition (FAR)

Fish Community: No fish species collected or expected.

Macroinvertebrate Community Quality O/E: The community sampled is consistent with a Wyoming Basin Perennial Spring Creek Assemblage sharing 15 of 20 reference condition invertebrates

Macroinvertebrate Community Quality: DEQ MMI= 43.7

Commissary Creek (YL Pr196)

Ecoregion: Bighorn-Pryor Mountains/Wyoming Basin (Typical)

Aquatic Ecological System Type: D001y-Forested Headwater Stream



Key Environmental Factors: Grazing—slight-moderate impacts, some fenced areas-but channel intrusions and degradation have increased the width of the stream far more than it needs to be. Pocked and hummocked along the stream margins.

Rare or Unique Species: Surprisingly 2 coldwater invertebrate taxa are persisting in this degraded stream channel.

Introduced/Exotic Species: None documented

Overall Ecological Site Condition: Degraded trending to Fair with improved cattle management.

Reach Riparian Ranking: BLM= 17 (70%) FAR

Macroinvertebrate Community Quality O/E: The community sampled is consistent with a moderately degraded forested headwater stream sharing only 2 coldwater taxa common to reference condition invertebrates. The MMI does not accurately reflect how degraded the community largely due to the small sample size collected.

Macroinvertebrate Community Quality: DEQ MMI= 53.9

Sage Creek Mainstem (YL Pr212)

Ecoregion: Bighorn-Pryor Foothills/Wyoming Basin (Typical)

Aquatic Ecological System Type: Small Transitional Foothills Stream (AES C001y)

Key Environmental Factors: Riparian Grazing & Cattle Use—moderate impacts upstream, none in the immediate area. Heavy sediment loading from upstream riparian cattle use.



Rare or Unique Species: No SOC species, but a two unique riffle beetles, *Lara avara* and *Narpus concolor* (cold-water obligate coleopteran taxa).

Introduced/Exotic Species: None documented

Geomorphology: Rosgen F4

Overall Ecological Site Condition:

Degraded trending to Fair with improved instream habitat conditions and upstream cattle management.

Riparian Ranking: BLM= 19 (79%)

Functional At Risk Riparian Condition (FAR)

Macroinvertebrate Community

Quality: A fairly diverse community of 39 taxa, including 4 cold-water obligate taxa, despite some obvious impairments from sediment loading issues, riparian degradation and heavy patches of aquatic vegetation. Community species are indicative of warmer water temps and dominance of finer benthic substrates.

Macroinvertebrate Community

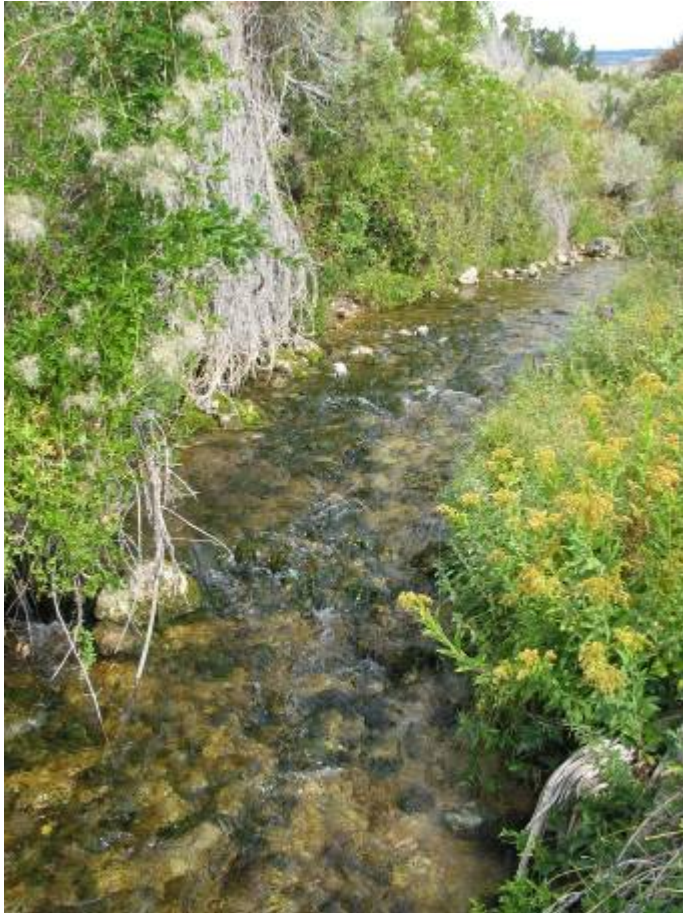
Quality: DEQ MMI= 46.19

Piney Creek (BLM Section YL Pr184)

Ecoregion: Bighorn-Pryor Foothills/Wyoming Basin (Typical)

Aquatic Ecological System Type: Small Transitional Foothills Stream (AES C001y)

Key Environmental Factors: Riparian Grazing & Cattle Use—slight impacts in the BLM section, some pocking and hummocking, none in the USFS spring outflow area. High discharge spring about 500m upstream.



Rare or Unique Species: Reported

Yellowstone cutthroat trout in reach (USFS pers. comm.). No SOC rare invertebrate species, but a good quality cold-water assemblage dominating the macroinverts.

Rare Features: No rare features documented, except a high discharge spring about 500m upstream pumping out pure snowmelt @ 5 degrees C.

Riparian Ranking: BLM= 19 (79%)

Functional At Risk Riparian Condition (FAR)

Geomorphology: Rosgen B3 Substrate looks very similar to Crooked Creek canyon sites including moss covered cobbles.

Introduced/Exotic Aquatic Species: None documented

Overall Ecological Site Condition: Good (2007 & 2008)

Macroinvertebrate Community: A good quality & fairly diverse community of 29 taxa, including 9 cold-water obligate taxa, despite some obvious sediment and grazing issues within the reach.

Macroinvertebrate Community Quality: MT MMI= 62.97

Literature Cited

- Barbour, M., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. United States Environmental Protection Agency; Office of Water: Washington, D.C..
- Feldman, D. 2006. Interpretation of New Macroinvertebrate Models by WQPB. Draft Report. Montana Department of Environmental Quality, Planning Prevention and Assistance Division, Water Quality Planning Bureau, Water Quality Standards Section. 1520 E. 6th Avenue, Helena, MT 59620. 14 pp.
- Jessup, B., J. Stribling; and C. Hawkins. 2005. Biological Indicators of Stream Condition in Montana Using Macroinvertebrates. Tetra Tech, Inc. November 2005 (draft).
- Jessup, B. 2006. Ecological Data Application System (EDAS) Version MT 3.3.2k A User's Guide. Tetra Tech, Inc.
- Lazorchak, J.M., Klemm, D.J., and D.V. Peck (editors). 1998. Environmental Monitoring and Assessment Program - Surface Waters: Field Operations and Methods for Measuring the Ecological Condition of Wadeable Streams. EPA/620/R-94/004F. U.S. Environmental Protection Agency, Washington, D.C.
- Montana Department of Environmental Quality (DEQ). 2005. Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates. Water Quality Planning Bureau. Standard Operation Procedure (WQPBWQM-009).
- Stagliano, David, M. 2008. Aquatic Macroinvertebrate Inventory & Assessment of Springs and Seeps within Bighorn Canyon National Recreation Area (BICA), Report to the Western National Parks Association and the Greater Yellowstone Network Inventory & Monitoring Program, National Park Service. <http://mtnhp.org/reports/BICASprings.pdf>
- Stagliano, David, M. 2005. Aquatic Community Classification and Ecosystem Diversity in Montana's Missouri River Watershed. Report to the Bureau of Land Management. Montana Natural Heritage Program, Helena, Montana. 65 pp. plus appendices. <http://www.mtnhp.org/reports.asp#Ecology>

Appendix A. Macroinvertebrate Taxa / Species by site for the 2008 USFS/BLM Pryors Asseesment. O.T.U is the taxonomic unit that the MMI uses in the calculations. Rep= Replicate sample. Bolded taxa are cold-water stenotherms (obligate indicator taxa)

Crooked Creek	O.T.U	Final Taxa ID	Rep 1	Rep 2	
Below barrier					
YL_Pr186	Dryopidae	<i>Helichus striatus</i>	3	2	
YL_Pr186	Microcylloepus	<i>Microcylloepus pusillus</i>	13	8	
YL_Pr186	Optioservus	<i>Optioservus</i> <i>quadrimaculatus</i>	32	21	
YL_Pr186	Chelifera_Metachela	<i>Chelifera</i>	6	4	
YL_Pr186	Chironominae	<i>Micropsectra</i>	36	21	
YL_Pr186	Chironominae	<i>Rheotanytarsus</i>	31	20	
YL_Pr186	Diamesinae	<i>Pagastia</i>	55	33	
YL_Pr186	Diamesinae	<i>Pseudodiamesa</i>	9	6	
YL_Pr186	Orthocladiinae	<i>Eukiefferiella devonica</i>	23	12	
YL_Pr186	Orthocladiinae	<i>Eukiefferiella Gracei Gr.</i>	9	4	
YL_Pr186	Orthocladiinae	<i>Parametriocnemus</i>	12	8	
YL_Pr186	Orthocladiinae	<i>Tvetenia bavarica</i>	58	22	
YL_Pr186	Simuliidae	<i>Prosimulium</i>	16	8	
YL_Pr186	Tipula	<i>Tipula</i>	2	1	
YL_Pr186	Baetis	<i>Baetis bicaudatus</i>	160	122	
YL_Pr186	Cinygmula	<i>Cinygmula</i>	79	42	
YL_Pr186	Drunella doddsi	<i>Drunella doddsi</i>	14	5	
YL_Pr186	Serratella	<i>Serratella tibialis</i>	13	8	
YL_Pr186	Amphinemura	<i>Amphinemura banksi</i>	29	18	
YL_Pr186	Doroneuria	<i>Doroneuria theodora</i>	11	3	
YL_Pr186	Hesperoperla	<i>Hesperoperla pacifica</i>	26	11	
YL_Pr186	Kogotus	<i>Kogotus modestus</i>	3	2	
YL_Pr186	Malenka	<i>Malenka</i>	5	3	
YL_Pr186	Zapada	<i>Zapada cinctipes</i>	60	27	
YL_Pr186	Brachycentrus	<i>Brachycentrus americanus</i>	6	2	
YL_Pr186	Neothremma	<i>Neothremma alicia</i>	304	176	
YL_Pr186	Parapsyche	<i>Parapsyche elsis</i>	10	7	
YL_Pr186	Psychoglypha	<i>Psychoglypha</i>	3	1	
YL_Pr186	Rhyacophila brunnea Gr.	<i>Rhyacophila Brunnea Gr.</i>	20	8	
YL_Pr186	Rhyacophila sibirica gr.	<i>Rhyacophila narvae</i>	1	0	
		Total Taxa	30	29	29.5
Crooked Creek Above barrier					
YL_Pr187	Ameletus	<i>Ameletus similior</i>	30	22	
YL_Pr187	Turbellaria	<i>Polycelis coronata</i>	24	13	
YL_Pr187	Heterlimnius	<i>Heterlimnius corpulentus</i>	11	11	
YL_Pr187	Microcylloepus	<i>Microcylloepus pusillus</i>	5	0	
YL_Pr187	Optioservus	<i>Optioservus</i> <i>quadrimaculatus</i>	5	0	
YL_Pr187	Chelifera_Metachela	<i>Chelifera</i>	6	4	
YL_Pr187	Chironominae	<i>Micropsectra</i>	95	45	
YL_Pr187	Chironominae	<i>Rheotanytarsus</i>	11	0	
YL_Pr187	Diamesinae	<i>Pagastia</i>	28	7	
YL_Pr187	Diamesinae	<i>Pseudodiamesa</i>	1	0	

YL_Pr187	Dicranota	<i>Dicranota</i>	1	0
YL_Pr187	Hexatoma	<i>Hexatoma</i>	1	2
YL_Pr187	Muscidae	<i>Limnophora</i>	3	9
YL_Pr187	Orthocladiinae	<i>Brillia</i>	8	5
YL_Pr187	Orthocladiinae	<i>Cricotopus</i>	6	0
YL_Pr187	Orthocladiinae	<i>Eukiefferiella Brehmi Gr.</i>	8	8
YL_Pr187	Orthocladiinae	<i>Eukiefferiella devonica</i>	12	3
YL_Pr187	Orthocladiinae	<i>Eukiefferiella Gracei Gr.</i>	5	0
YL_Pr187	Orthocladiinae	<i>Hydrobaenus</i>	1	1
YL_Pr187	Orthocladiinae	<i>Parametriocnemus</i>	6	3
YL_Pr187	Orthocladiinae	<i>Rheocricotopus</i>	7	3
YL_Pr187	Orthocladiinae	<i>Tvetenia bavarica</i>	55	11
YL_Pr187	Pericoma/Telmatoscopus	<i>Pericoma</i>	6	2
YL_Pr187	Simuliidae	<i>Prosimulium</i>	2	0
YL_Pr187	Tipula	<i>Tipula</i>	2	2
YL_Pr187	Baetis	<i>Baetis bicaudatus</i>	169	133
YL_Pr187	Cinygmula	<i>Cinygmula</i>	157	97
YL_Pr187	Drunella coloradensis	<i>Drunella coloradensis</i>	64	27
YL_Pr187	Drunella doddsi	<i>Drunella doddsi</i>	13	9
YL_Pr187	Epeorus	<i>Epeorus longimanus</i>	4	5
YL_Pr187	Serratella	<i>Serratella tibialis</i>	39	23
YL_Pr187	Amphinemura	<i>Amphinemura banksi</i>	5	2
YL_Pr187	Chloroperlidae	<i>Sweltsa</i>	34	13
YL_Pr187	Hesperoperla	<i>Hesperoperla pacifica</i>	28	20
YL_Pr187	Isoperla	<i>Isoperla</i>	4	2
YL_Pr187	Kogotus	<i>Kogotus modestus</i>	3	0
YL_Pr187	Leuctridae	<i>Despaxia augusta</i>	1	1
YL_Pr187	Malenka	<i>Malenka</i>	6	1
YL_Pr187	Zapada	<i>Zapada cinctipes</i>	47	32
YL_Pr187	Zapada	<i>Zapada oregonensis gr.</i>	7	1
YL_Pr187	Brachycentrus	<i>Brachycentrus americanus</i>	2	2
YL_Pr187	Dolophilodes	<i>Dolophilodes</i>	3	0
YL_Pr187	Ecclisomyia	<i>Ecclisomyia</i>	1	2
YL_Pr187	Lepidostoma	<i>Lepidostoma cascadense</i>	1	1
YL_Pr187	Neothremma	<i>Neothremma alicia</i>	216	161
YL_Pr187	Rhyacophila brunnea Gr	<i>Rhyacophila Brunnea Gr.</i>	41	21
YL_Pr187	Rhyacophila sibirica gr.	<i>Rhyacophila narvae</i>	6	2
YL_Pr187	Rhyacophila vagrita gr.	<i>Rhyacophila vagrita</i>	9	0
Total Taxa			48	37
				42.5

Appendix A. Continued.

Crooked Creek upper canyon	Final Taxa ID	# of Indiv.	Piney Creek (BLM)	Final Taxa ID	# of Indiv.
YL_Pr188	<i>Amphinemura banksi</i>	3	YL_Pr184	<i>Amphinemura banksi</i>	35
YL_Pr188	Baetis bicaudatus	24	YL_Pr184	<i>Atractides</i>	2
YL_Pr188	<i>Brillia</i>	3	YL_Pr184	<i>Baetis tricaudatus</i>	110
YL_Pr188	<i>Chelifera</i>	2	YL_Pr184	<i>Brillia</i>	25
YL_Pr188	Cinygmula	60	YL_Pr184	Cinygmula	75
YL_Pr188	<i>Dicranota</i>	1	YL_Pr184	<i>Cricotopus</i>	5
YL_Pr188	<i>Dolophilodes</i>	3	YL_Pr184	Diamesa	2
YL_Pr188	Drunella coloradensis	64	YL_Pr184	<i>Dicranota</i>	18
YL_Pr188	<i>Epeorus longimanus</i>	4	YL_Pr184	Drunella coloradensis	35
YL_Pr188	<i>Isoperla</i>	2	YL_Pr184	<i>Eukiefferiella devonica</i>	12
YL_Pr188	Kogotus modestus	3	YL_Pr184	<i>Eukiefferiella gracei</i>	2
YL_Pr188	<i>Lepidostoma cascadenense</i>	1	YL_Pr184	<i>Helophorus</i>	2
YL_Pr188	<i>Limnophora</i>	3	YL_Pr184	Heterlimnius corpulentus	30
YL_Pr188	<i>Malenka</i>	6	YL_Pr184	<i>Heterotrissocladius marcidus</i>	5
YL_Pr188	<i>Micropsectra</i>	5	YL_Pr184	Kogotus modestus	5
YL_Pr188	Neothremma alicia	2	YL_Pr184	<i>Limnophora</i>	1
YL_Pr188	<i>Optioservus quadrimaculatus</i>	5	YL_Pr184	Neothremma alicia	220
YL_Pr188	<i>Pagastia</i>	4	YL_Pr184	<i>Paraleptophlebia</i>	5
YL_Pr188	<i>Parametriocnemus</i>	5	YL_Pr184	Polycelis coronata	98
YL_Pr188	<i>Pericoma</i>	4	YL_Pr184	<i>Protzia</i>	2
YL_Pr188	Polycelis coronata	11	YL_Pr184	<i>Pseudodiamesa</i>	5
YL_Pr188	<i>Rheocricotopus</i>	4	YL_Pr184	<i>Rheocricotopus</i>	65
YL_Pr188	Rhyacophila brunnea gr.	3	YL_Pr184	<i>Rheotanytarsus</i>	12
YL_Pr188	Rhyacophila hyalinata gr.	31	YL_Pr184	Rhyacophila brunnea gr.	11
YL_Pr188	Rhyacophila vagrita	9	YL_Pr184	Sweltsa	15
YL_Pr188	<i>Serratella tibialis</i>	11	YL_Pr184	<i>Testudacarus</i>	1
YL_Pr188	Sweltsa	31	YL_Pr184	<i>Tipula</i>	4
YL_Pr188	<i>Zapada cinctipes</i>	3	YL_Pr184	<i>Zapada cinctipes</i>	3
YL_Pr188	Zapada Oregonensis gr.	6			
Total Taxa		29	Total Taxa		28

Appendix A. Continued.

Wyoming Creek	Final Taxa ID	# of Indiv.
UYL_WY5	<i>Amphinemura banksi</i>	54
UYL_WY5	Baetis bicaudatus	4
UYL_WY5	<i>Baetis tricaudatus</i>	17
UYL_WY5	<i>Brillia</i>	100
UYL_WY5	<i>Cardiocladius</i>	7
UYL_WY5	<i>Clinocera</i>	1
UYL_WY5	<i>Cricotopus</i>	18
UYL_WY5	<i>Dicranota</i>	3
UYL_WY5	<i>Dixa</i>	3
UYL_WY5	Drunella coloradensis	1
UYL_WY5	Drunella doddsi	2
UYL_WY5	<i>Ephemerella excrucians</i>	1
UYL_WY5	<i>Eukiefferiella brehmi gr.</i>	22
UYL_WY5	<i>Eukiefferiella devonica</i>	2
UYL_WY5	<i>Eukiefferiella gracei gr.</i>	10
UYL_WY5	<i>Euparyphus</i>	2
UYL_WY5	<i>Isoperla</i>	1
UYL_WY5	<i>Lepidostoma cascadense</i>	2
UYL_WY5	<i>Limnephilus</i>	1
UYL_WY5	<i>Limnophora</i>	2
UYL_WY5	<i>Micropsectra</i>	25
UYL_WY5	Neothremma alicia	2
UYL_WY5	<i>Orthocladius</i>	6
UYL_WY5	<i>Ostracoda</i>	10
UYL_WY5	<i>Pagastia</i>	20
UYL_WY5	<i>Parakiefferiella</i>	10
UYL_WY5	<i>Parametriocnemus</i>	5
UYL_WY5	<i>Polycelis coronata</i>	51
UYL_WY5	<i>Pseudodiamesa</i>	15
UYL_WY5	<i>Rheocricotopus</i>	14
UYL_WY5	Rhyacophila brunnea gr.	12
UYL_WY5	Rhyacophila oreta	1
UYL_WY5	Sweltsa	26
UYL_WY5	<i>Tipula</i>	5
UYL_WY5	<i>Tubificidae</i>	2
UYL_WY5	<i>Tvetenia bavarica</i>	6
UYL_WY5	Zapada Oregonensis gr.	27
Total Taxa		37

Appendix A. Continued.

Crooked Creek trib/upper canyon	Final Taxa ID	# of Indiv.	Crooked Creek source	Final Taxa ID	# of Indiv.
YL_Pr191	<i>Amphinemura banksi</i>	66	YL_Pr192	<i>Ablabesmyia</i>	1
YL_Pr191	<i>Baetis bicaudatus</i>	5	YL_Pr192	<i>Amphinemura banksi</i>	11
YL_Pr191	<i>Brachycentrus americanus</i>	40	YL_Pr192	<i>Atractides</i>	2
YL_Pr191	<i>Diamesa</i>	12	YL_Pr192	<i>Caloparyphus</i>	1
YL_Pr191	<i>Dicranota</i>	25	YL_Pr192	<i>Cinygmula</i>	1
YL_Pr191	<i>Dipheter hageni</i>	4	YL_Pr192	<i>Euparyphus</i>	2
YL_Pr191	<i>Eukiefferiella Gracei Gr.</i>	3	YL_Pr192	<i>Fossaria humilis</i>	5
YL_Pr191	<i>Euparyphus</i>	4	YL_Pr192	<i>Hesperophylax designatus</i>	3
YL_Pr191	<i>Heterlimnius corpulentus</i>	86	YL_Pr192	<i>Hydrobius</i>	1
YL_Pr191	<i>Hydrobaenus</i>	48	YL_Pr192	<i>Limnephilus</i>	15
YL_Pr191	<i>Kogotus modestus</i>	8	YL_Pr192	<i>Micropsectra</i>	2
YL_Pr191	<i>Meringodixa chalonensis</i>	5	YL_Pr192	<i>Ochthebius</i>	1
YL_Pr191	<i>Micrasema bactro</i>	2	YL_Pr192	<i>Parametriocnemus</i>	3
YL_Pr191	<i>Monodiamesa</i>	6	YL_Pr192	<i>Simulium</i>	25
YL_Pr191	<i>Neothremma alicia</i>	5	YL_Pr192	<i>Sphaerium</i>	4
YL_Pr191	<i>Ochthebius</i>	1		Total Taxa	15
YL_Pr191	<i>Optioservus quadrimaculatus</i>	7			
YL_Pr191	<i>Ostracoda</i>	22			
YL_Pr191	<i>Pagastia</i>	17			
YL_Pr191	<i>Pericoma</i>	2			
YL_Pr191	<i>Polycelis coronata</i>	45			
YL_Pr191	<i>Pseudodiamesa</i>	11			
YL_Pr191	<i>Psychoglypha</i>	4			
YL_Pr191	<i>Radotanypus</i>	2			
YL_Pr191	<i>Rhyacophila Brunnea Gr.</i>	25			
YL_Pr191	<i>Serratella tibialis</i>	7			
YL_Pr191	<i>Simulium</i>	5			
YL_Pr191	<i>Sphaerium fabale</i>	5			
YL_Pr191	<i>Tanytarsus</i>	2			
YL_Pr191	<i>Zapada cinctipes</i>	2			
	Total Taxa	30			

Appendix A. Continued.

Sage Creek Springs	Final Taxa ID	# of Indiv.	Commissary Creek	Final Taxa ID	# of Indiv.
YL_PryS1	<i>Argia</i>	4	YL_Pr196	<i>Cinygmula</i>	88
YL_PryS1	<i>Caloparyphus</i>	2	YL_Pr196	<i>Hydrobaenus</i>	25
YL_PryS1	<i>Sphaerium</i>	5	YL_Pr196	<i>Polycelis coronata</i>	23
YL_PryS1	<i>Baetis tricaudatus</i>	4	YL_Pr196	<i>Tvetenia bavarica</i>	12
YL_PryS1	<i>Tubificidae</i>	2	YL_Pr196	<i>Pseudodiamesa</i>	6
YL_PryS1	<i>Fossaria humilis</i>	7	YL_Pr196	<i>Hesperophylax designatus</i>	12
YL_PryS1	<i>Hesperophylax designatus</i>	9	YL_Pr196	<i>Amphinemura banksi</i>	22
YL_PryS1	<i>Valvata lewisi</i>	1		Total Taxa	7
YL_PryS1	<i>Radotanypus</i>	1	Rock Creek Spring		
YL_PryS1	<i>Pseudosuccinea columella</i>	1	YL_Pr202	<i>Limnophora</i>	4
YL_PryS1	<i>Cymbiodyta</i>	2	YL_Pr202	<i>Pseudodiamesa</i>	11
YL_PryS1	<i>Hydroporus</i>	2	YL_Pr202	<i>Zapada Oregonensis gr.</i>	1
	Total Taxa	12	YL_Pr202	<i>Baetis tricaudatus</i>	45
			YL_Pr202	<i>Tanytarsus</i>	5
YL_PryS2	<i>Caloparyphus</i>	12	YL_Pr202	<i>Amphinemura banksi</i>	77
YL_PryS2	<i>Sphaerium</i>	5	YL_Pr202	<i>Diamesa</i>	5
YL_PryS2	<i>Baetis tricaudatus</i>	13	YL_Pr202	<i>Hydrobaenus</i>	25
YL_PryS2	<i>Hesperophylax designatus</i>	9	YL_Pr202	<i>Dipheter hageni</i>	3
YL_PryS2	<i>Valvata lewisi</i>	4	YL_Pr202	<i>Dicranota</i>	2
YL_PryS2	<i>Radotanypus</i>	4	YL_Pr202	<i>Parametrioctenus</i>	4
YL_PryS2	<i>Cymbiodyta</i>	1	YL_Pr202	<i>Polycelis coronata</i>	32
YL_PryS2	<i>Amphiagrion abbreviatum</i>	3		Total Taxa	12
	Total Taxa	8			

Appendix A. Continued.

Sage Creek (campground)	Final Taxa ID	# of Indiv.	Sage Creek (down)	Final Taxa ID	# of Indiv.
YL_Pr212	<i>Ameletus oregonensis</i>	6	YL_Pr213	<i>Ameletus oregonensis</i>	1
YL_Pr212	<i>Amphinemura banksi</i>	30	YL_Pr213	<i>Amphinemura banksi</i>	22
YL_Pr212	<i>Baetis tricaudatus</i>	14	YL_Pr213	<i>Baetis tricaudatus</i>	53
YL_Pr212	<i>Brachycentrus americanus</i>	1	YL_Pr213	<i>Brachycentrus americanus</i>	23
YL_Pr212	<i>Cleptelmis addenda</i>	2	YL_Pr213	<i>Cleptelmis addenda</i>	6
YL_Pr212	<i>Diphetor hageni</i>	4	YL_Pr213	<i>Diphetor hageni</i>	5
YL_Pr212	<i>Ecclisomyia</i>	1	YL_Pr213	<i>Ecclisomyia</i>	1
YL_Pr212	<i>Ephemerella excrucians</i>	15	YL_Pr213	<i>Ephemerella excrucians</i>	23
YL_Pr212	<i>Hydroptila</i>	1	YL_Pr213	<i>Hydroptila</i>	7
YL_Pr212	Lara avara	1	YL_Pr213	Lara avara	5
YL_Pr212	<i>Larsia</i>	3	YL_Pr213	<i>Larsia</i>	1
YL_Pr212	<i>Lepidostoma unicolor</i>	3	YL_Pr213	<i>Lepidostoma unicolor</i>	1
YL_Pr212	<i>Limnophila</i>	1	YL_Pr213	<i>Limnophila</i>	2
YL_Pr212	<i>Lumbricina</i>	5	YL_Pr213	<i>Lumbricina</i>	11
YL_Pr212	<i>Micrasema bactro</i>	3	YL_Pr213	<i>Micrasema bactro</i>	6
YL_Pr212	<i>Musculium</i>	10	YL_Pr213	<i>Musculium</i>	10
YL_Pr212	Narpus concolor	2	YL_Pr213	Narpus concolor	4
YL_Pr212	<i>Odontomesa</i>	1	YL_Pr213	<i>Odontomesa</i>	1
YL_Pr212	<i>Optioservus</i>	1	YL_Pr213	<i>Optioservus</i>	7
YL_Pr212	<i>Oreodytes</i>	1	YL_Pr213	<i>Oreodytes</i>	1
YL_Pr212	<i>Pagastia</i>	7	YL_Pr213	<i>Pagastia</i>	2
YL_Pr212	<i>Paraleptophlebia</i>	90	YL_Pr213	<i>Paraleptophlebia</i>	36
YL_Pr212	<i>Parametriocnemus</i>	2	YL_Pr213	<i>Parametriocnemus</i>	12
YL_Pr212	<i>Pentaneura</i>	1	YL_Pr213	<i>Pentaneura</i>	7
YL_Pr212	<i>Physella</i>	3	YL_Pr213	<i>Physella</i>	31
YL_Pr212	<i>Pisidium</i>	40	YL_Pr213	<i>Pisidium</i>	40
YL_Pr212	<i>Polycentropus</i>	4	YL_Pr213	<i>Pseudodiamesa</i>	2
YL_Pr212	<i>Prodiamesa</i>	2	YL_Pr213	<i>Ptychoptera</i>	44
YL_Pr212	<i>Pseudodiamesa</i>	1	YL_Pr213	<i>Radotanypus</i>	1
YL_Pr212	<i>Ptychoptera</i>	34	YL_Pr213	<i>Rheocricotopus</i>	6
YL_Pr212	<i>Radotanypus</i>	7	YL_Pr213	Rhyacophila brunnea gr.	2
YL_Pr212	<i>Rheocricotopus</i>	6	YL_Pr213	<i>Serratella tibialis</i>	5
YL_Pr212	Rhyacophila brunnea gr.	5	YL_Pr213	<i>Sialis velata</i>	2
YL_Pr212	<i>Serratella tibialis</i>	4	YL_Pr213	<i>Simulium</i>	33
YL_Pr212	<i>Sialis velata</i>	2	YL_Pr213	<i>Thienemannimyia gr.</i>	12
YL_Pr212	<i>Simulium</i>	13	YL_Pr213	<i>Tipula</i>	4
YL_Pr212	<i>Thienemannimyia gr.</i>	2	YL_Pr213	<i>Zapada cinctipes</i>	17
YL_Pr212	<i>Tipula</i>	3	YL_Pr213	<i>Tubificidae</i>	11
YL_Pr212	Zapada oregonensis gr.	2			
	Total Taxa	39		Total Taxa	38